APPENDIX B

HYDROLOGICAL SIMULATION PROGRAM-FORTRAN (HSPF) MODEL

APPENDIX B.1

HYDROLOGICAL SIMULATION PROGRAM-FORTRAN (HSPF) MODEL DESCRIPTION

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APPENDIX B

HYDROLOGICAL SIMULATION PROGRAM-FORTRAN (HSPF) MODEL DESCRIPTION

In the mid-1970s, the U.S. EPA Environmental Research Laboratory in Athens, Georgia, was in the beginning stages of model development and testing efforts that focused on tools and procedures for quantifying nonpoint sources (NPS) of pollution. Initiated by legislative mandates that required assessment of both urban and agricultural NPS contaminants, the laboratory was supporting development and field testing of mathematical models (along with companion data collection programs) to be used to estimate these NPS loadings and, ultimately, to evaluate potential management and control alternatives. However, EPA scientists realized that although these field-scale models could provide loading values, they alone would not be sufficient to evaluate water quality impacts at the larger watershed, or regional scale. Thus, an extensive, comprehensive watershed model development effort was begun to integrate the field-scale models with instream hydraulic and water quality process models within a flexible, modular framework, to allow continuous simulation of complex watersheds with multiple land uses, both point and nonpoint contaminant sources, networked channels and drainage patterns, and lakes and reservoirs. The HSPF model produced by this development effort has been applied throughout North America and numerous countries and climates; it has the joint sponsorship of both the EPA and USGS, and continues to undergo refinement and enhancement of its component simulation capabilities along with user support and code maintenance activities.

Overview

The Hydrological Simulation Program-FORTRAN, known as HSPF, is a mathematical model developed under EPA sponsorship for use on digital computers to simulate hydrologic and water quality processes in natural and man-made water systems. It is an analytical tool that has application in the planning, design, and operation of water resources systems. The model enables the use of probabilistic analysis in the fields of hydrology and water quality management. HSPF uses such information as the time history of rainfall, temperature, evaporation, and parameters related to land use patterns, soil characteristics, and agricultural practices to simulate the processes that occur in a watershed. The initial result of an HSPF simulation is a time history of the quantity and quality of water transported over the land surface and through various soil zones down to the groundwater aquifers. Runoff flow rate, sediment loads, nutrients, pesticides, toxic chemicals, and other water quality constituent concentrations can be predicted. The model uses these results and stream channel information to simulate instream processes. From this information, HSPF produces a time history of water quantity and quality at any point in the watershed.

HSPF is currently one of the most comprehensive and flexible models of watershed hydrology and water quality available. It is one of a small number of available models that can simulate the continuous, dynamic event, or steady-state behavior of both hydrologic/hydraulic and water quality processes in a watershed, with an integrated linkage of surface, soil, and stream processes. The model is also unusual in its ability to represent the hydrologic regimes of a wide variety of streams and rivers with reasonable accuracy. It has been applied to such diverse climatic regimes as the tropical rain forests of the Caribbean, the arid conditions of Saudi Arabia and the southwestern U.S., the humid eastern U.S. and Europe, and the snow-covered regions of eastern Canada. The potential applications and uses of the model are comparatively large and include the following:

- Flood control planning and operations.
- Hydropower studies.
- River basin and watershed planning.
- Storm drainage analyses.
- Water quality planning and management.
- Point and nonpoint source pollution analyses.
- Soil erosion and sediment transport studies.
- Evaluation of urban and agricultural best management practices.
- Fate, transport, exposure assessment, and control of pesticides, nutrients, and toxic substances.
- Time-series data storage, analysis, and display.

HSPF is designed so that it can be applied to most watersheds using existing meteorologic and hydrologic data; soils and topographic information; and land use, drainage, and system (physical and man-made) characteristics. The inputs required by HSPF are not different from those needed by most other simpler models. The primary difference in data needs is that long, rather than short time-series records are preferred. Typical long time-series records include precipitation, waste discharges, and calibration data such as streamflow and constituent concentrations.

Historical Development

HSPF is an extension and improvement of three previously developed models: 1) The EPA Agricultural Runoff Management Model - ARM (Donigian and Davis, 1978), 2) The EPA Nonpoint Source Runoff Model - NPS (Donigian and Crawford, 1979), and 3) The Hydrologic Simulation Program (HSP), including HSP Quality (Hydrocomp, 1977), a privately developed proprietary program. In the late 1970s EPA recognized that the continuous simulation approach contained in these models would be valuable in solving many complex water resource problems. Thus, a fairly large investment was devoted to developing a highly flexible nonproprietary FORTRAN program containing the capabilities of these three models, plus many extensions.

HSPF incorporates the field-scale ARM and NPS models into a watershed-scale analysis framework that includes the capabilities needed to model fate and transport in one-dimensional stream channels. It is the only comprehensive model of watershed hydrology and water quality that allows the integrated simulation of land and soil contaminant runoff processes with instream hydraulic and sediment-chemical interactions.

HSPF was first released publicly in 1980, as Release No. 5 (Johanson et al., 1980), by the U.S. EPA Water Quality Modeling Center (now the Center for Exposure Assessment Modeling). Since its initial release, the model has maintained a reputation as perhaps the most useful watershed-scale hydrology/water quality model available within the public domain. The development of HSPF in the late 1970s represented an integration of a variety of EPA-sponsored model development and testing efforts. The basic watershed modeling philosophy and approach embodied in HSP was chosen, a highly modular code design and structure was developed, and all the individual models were redesigned and recoded into FORTRAN to make the resulting package widely usable and available to potential model users. Throughout the 1980s and early 1990s, HSPF underwent a series of code and algorithm enhancements producing a continuing succession of new releases of the code, culminating in the recent release of Version No. 11 (Bicknell et al., 1997). Table 1 lists some of the key enhancements and changes for the various HSPF releases since 1980.

Since 1981, USGS has been developing software to facilitate watershed modeling by providing interactive capabilities for model input development, data storage and data analysis, and model output analysis including hydrologic calibration assistance. The ANNIE, WDM, Scenario Generator (GenScn), and HSPEXP software are USGS products that have greatly advanced and facilitated watershed model applications, not only for HSPF but also for many other USGS models. For example, the WDM (Watershed Data Management) file has effectively replaced the Time Series Store (TSS) file used in the earlier versions of HSPF due to the expanded data analysis and graphical capabilities of the ANNIE software (Flynn et al., 1995), which is designed to interact with WDM files.

Since its initial release in 1980, HSPF applications have been worldwide and number in the hundreds; approximately 50 current active applications continue around the world with the greatest concentration in North America. Numerous studies have been completed or are continuing in the Pacific Northwest, the Washington, DC, metropolitan area, and the Chesapeake Bay region. Table 2 lists a few current HSPF applications, most of which are discussed by Donigian et al. (1995). Today the model serves as the focal point for cooperation and integration of watershed modeling and model support efforts between EPA and USGS. Over the years, development activities and model enhancements, along with these model applications, have continued to improve the model's capabilities and preserve its status as a state-of-the-art tool for watershed analysis.

Overview of HSPF Capabilities and Components

HSPF contains three application modules and five utility modules. The three application modules simulate the hydrologic/hydraulic and water quality components of the watershed. The utility

Table 1

Historical Progression of HSPF Releases

Year	Version	Comments/Enhancements	Document
1980	5	Initial public release	Johanson et al. (1980)
	6	Performance and portability enhancements	
1981	7	GQUAL, SEDTRN, MUTSIN, GENER, DURANL enhancements	Johanson et al. (1981)
1984	8	Special Actions enhancements Initial PC version	Johanson et al. (1984) Application Guide (Donigian et al., 1984)
1988	9	WDM implementation PC version distributed	CEAM publication
1993	10	Sediment-nutrient interactions Mass-Link/Schematic Acid-pH Module	HSPF Rel. 10 Manual (Bicknell et al., 1993)
1996	11	Enhanced special actions Water regulation/accounting Atmospheric deposition HSPF/DSS linkage (COE) Increase operations limit Forest Nitrogen Module	HSPF Rel. 11 Manual (Bicknell et al., 1997)

Table 2

Selected Recent and/or Current HSPF Applications

- Chesapeake Bay Watershed Model of nutrient loadings and management alternatives
- Seattle Metropolitan Area watershed and urban drainage studies
- Metropolitan Washington, DC, urban nonpoint and water quality studies
- U.S. EPA Office of Pesticide Programs assessment of alachlor surface water concentrations
- Sydney Water Board (Australia) assessment of water supply quality and nonpoint pollution
- Maryland Department of the Environment Patuxent River nonpoint source study
- Numerous Florida applications for hydrologic assessments, nutrient loadings and water quality simulation
- Flooding and Water Resource Development studies for Saudi Arabian Ministry of Agriculture
- Upper Grande Ronde (OR) temperature TMDL
- Walnut Creek (IA) MSEA/MASTER surface water exposure assessment
- Minnesota River Nonpoint Source Assessment Project
- Water Management for the Humber River, South Africa
- Long Island Sound Nutrient Study
- Copper Mine Impact Assessment (WI) - EPA/USGS/USACE

modules are used to manipulate and analyze time-series data. Table 3 summarizes the constituents and capabilities of the HSPF modules. A brief description of the three modules follows:

1) PERLND-Simulates runoff and water quality constituents from pervious land areas in the watershed.

2) IMPLND-Simulates impervious land area runoff and water quality.

3) RCHRES-Simulates the movement of runoff water and its associated water quality constituents in stream channels and mixed reservoirs.

PERLND Module

Because PERLND simulates the water quality and quantity processes that occur on pervious land areas, it is the most frequently used part of HSPF. To simulate these processes, PERLND models the movement of water along three paths: overland flow, interflow, and groundwater flow. Each of these three paths experiences differences in time delay and differences in interactions between water and its various dissolved constituents. A variety of storage zones are used to represent the processes that occur on the land surface and in the soil horizons. Snow accumulation and melt are also included in the PERLND module so that the complete range of physical processes affecting the generation of water and associated water quality constituents can be represented. Some of the many capabilities available in the PERLND module include the simulation of:

- Water budget and runoff components.
- Snow accumulation and melt.
- Sediment production and removal.
- Accumulation and washoff of user-defined nonpoint pollutants.
- Nitrogen and phosphorus fate and runoff.
- Pesticide fate and runoff.
- Movement of a tracer chemical.

Figure 1 defines the structure and contents of the PERLND module. The PERLND module features individual compartments (i.e., subroutine groups) for specific modeling capabilities, including: air temperature as a function of elevation (ATEMP), snow accumulation and melting (SNOW), hydrologic water budget (PWATER), sediment production and removal (SEDMNT), soil temperature (PSTEMP), surface runoff water temperature and gas concentrations (PWTGAS), generalized water quality constituents (PQUAL), solute transport (MSTLAY), pesticides (PEST), nitrogen (NITR), phosphorus (PHOS), and conservatives (TRACER).

PWATER is used to calculate the water budget components resulting from precipitation on pervious land areas; as a result, it is the key component of the PERLND module. The basis of the water budget computations contained in HSPF is the Stanford Watershed Model (Crawford and Linsley, 1966). Like the SNOW code, the PWATER code uses both physical and empirical formulations to

Table 3

HSPF Application and Utility Modules

Application Modules		
PERLND	**IMPLND**	**RCHRES**
Snow Water Sediment Soil temperature Water Quality* Pesticide Nitrogen Phosphorus Tracer	Snow Water Solids Water Quality*	Hydraulics Conservative Temperature Sediment Nonconservatives BOD/DO Nitrogen Phosphorus Carbon/pH Plankton
Utility Modules		
COPY	**PLTGEN**	**DISPLAY**
Data transfer	Plot data	Tabulate, summarize
DURANL	**GENER**	**MUSTIN**
Duration	Transform or combine time-series data	Time-series data

* Up to 10 user–specified water quality parameters.

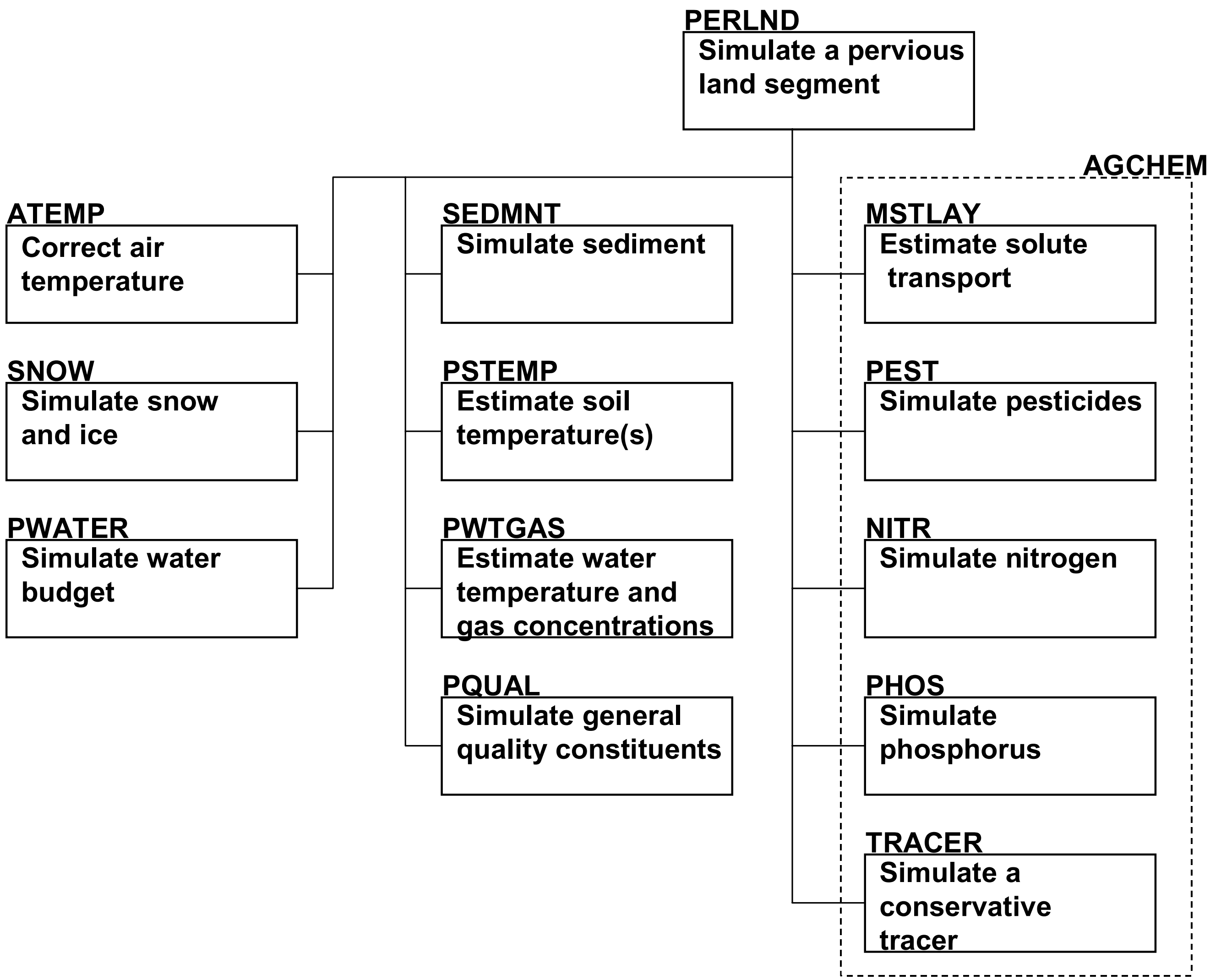

Figure 1 PERLND Structure Chart

model the movement of water through the hydrologic cycle. PWATER considers such processes as evapotranspiration; surface detention; surface runoff; infiltration; shallow subsurface flow (interflow); baseflow; and percolation to deep groundwater. Lateral inflows to surface and shallow subsurface storages can also be modeled.

The equations used in the SEDMNT code to produce and remove sediment are based on the ARM and NPS models, and are modifications of soil and gully erosion equations developed by Negev (1967) and influenced by Meyer and Wischmeier (1969) and Onstad and Foster (1975). Many of the sediment model parameters are derived from the Universal Soil Loss Equation (Wischmeier and Smith, 1978). Removal of sediment by water is simulated as washoff of detached sediment in storage and scour of the soil matrix. Soil detachment is modeled as a function of rainfall, land cover, land management practices, and soil detachment properties. If the modeler so specifies, soil detachment can be incremented by lateral input from an upslope land segment and/or net external additions/removals caused by human activities or wind. Removal of detached sediment and scour of the soil matrix by surface flow are both modeled empirically as a function of surface water storage and surface water outflow.

PWTGAS estimates the water temperature for surface, shallow subsurface (interflow) and groundwater outflows. The temperature of each outflow is considered to be the same as the soil temperature of the layer from which it originates. PWTGAS also computes the dissolved oxygen and carbon dioxide concentrations of overland flow using empirical formulations; concentrations are assumed to be at saturation. PQUAL simulates generalized water quality constituents in the outflows (surface and subsurface) from a pervious land segment using simple relationships with water and/or sediment yield. The behavior of a constituent in surface outflow is considered more complex and dynamic than the behavior in subsurface flow. The code allows quantities in surface outflow to be simulated by one, or both, of two methods. Either (1) a constituent can be modeled using "potency factors" to indicate constituent strength relative to the sediment removal computed by SEDMNT, or (2) storage of a constituent on the land surface can be modeled, considering accumulation and depletion/removal, and a first-order washoff rate of the available constituent can be removed by overland flow, as computed by PWATER. In addition, both formulations can be used for representing the washoff behavior of particulate and dissolved components of an specific pollutant.

The remaining five code compartments in PERLND are used together to model detailed behavior of soil nutrients (i.e., nitrogen and phosphorus) and nonreactive tracer chemicals (e.g., chloride). These five code sections have been referred to as the AGCHEM module because their primary use to date has been for modeling the mass balance and runoff of agricultural chemicals. MSTLAY estimates the storages and fluxes of moisture in the four soil layers—surface, upper, lower, groundwater—that define soil layers used by the remaining four code compartments. MSTLAY is required because the moisture storages and fluxes computed by PWATER must be modified to effectively simulate solute transport through the soil. Estimates of solute flux are computed based on the assumption that the concentration of solute being transported is the same as that for storage; uniform flow through the layers and continuous mixing of solutes is also assumed. Leaching retardation factors are computed to modify the solute fluxes from the top three soil layers based on user-defined model parameters.

PEST simulates pesticide behavior in the soil and runoff from pervious land segments in three forms: dissolved, adsorbed, and crystallized. The PEST code utilizes time-series data generated by other compartments of PERLND (i.e., PWATER, SEDMNT, MSTLAY) to compute transport (runoff and leaching), adsorption/desorption, and degradation. Pesticide transport is modeled as a function of water flow and/or association with transported sediment. Chemicals in solution move to, through, and from storages according to the fractions calculated in MSTLAY. Computations are performed that compute the movement of adsorbed pesticide associated with removal of sediment from the surface layer via scour and washoff. Adsorption/desorption is a function of both chemical and soil layer characteristics; several options for characterizing sorption are offered, including a first-order kinetic approach and the use of two different Freundlich isotherm methods. Degradation from all processes is modeled as a lumped rate in each of the four soil layers.

The NITR code section simulates the transport and soil reactions of nitrate, ammonia, and four forms of organic nitrogen. Nitrogen species are transported by the same methods used for pesticides. Nitrate and dissolved ammonium are transported as a function of water flow; organic nitrogen and adsorbed ammonium are removed from the surface layer storage by association with sediment scour and washoff; nitrate and ammonium in the soil water are transported according to the fractions calculated in MSTLAY; and computations are performed that compute the movement of adsorbed organic nitrogen and ammonium associated with removal of sediment from the topsoil surface layer. First-order kinetics or a Freundlich isotherm can be used to model adsorption/desorption. Nitrogen transformation processes (denitrification, nitrification, plant uptake, immobilization, mineralization, volatilization, plant nitrogen return to organic nitrogen) are modeled using temperature-corrected, first-order kinetics with separate rate constants defined for each soil layer.

PHOS simulates the transport and reaction of phosphate and organic phosphorus using methods parallel to those used for nitrogen species in NITR. Transport mechanisms for phosphate parallel those modeled for ammonium, and those for organic phosphorus parallel organic nitrogen. Like ammonium, phosphate adsorption/desorption can be modeled using either first-order kinetics or a Freundlich isotherm. Phosphorus transformation processes (plant uptake, immobilization, mineralization) are modeled using temperature-corrected, first-order kinetics with separate rate constants defined for each soil layer.

Typically, the TRACER code is applied to chloride (or bromide) to calibrate solute movement through the soil profile. This involves adjustment of leaching retardation factors until good agreement with observed soil chloride concentrations has been obtained. Once appropriate retardation values have been determined, they are used in PEST, NITR, and PHOS to simulate solute transport.

IMPLND Module

IMPLND is used for impervious land surfaces, primarily for urban land categories, where little or no infiltration occurs. However, some land processes do occur, and water, solids, and various pollutants are removed from the land surface by moving laterally downslope to a pervious area, stream channel, or reservoir. IMPLND includes most of the pollutant washoff capabilities of the commonly used urban runoff models, such as the STORM, SWMM, and NPS models. Figure 2 defines the structure

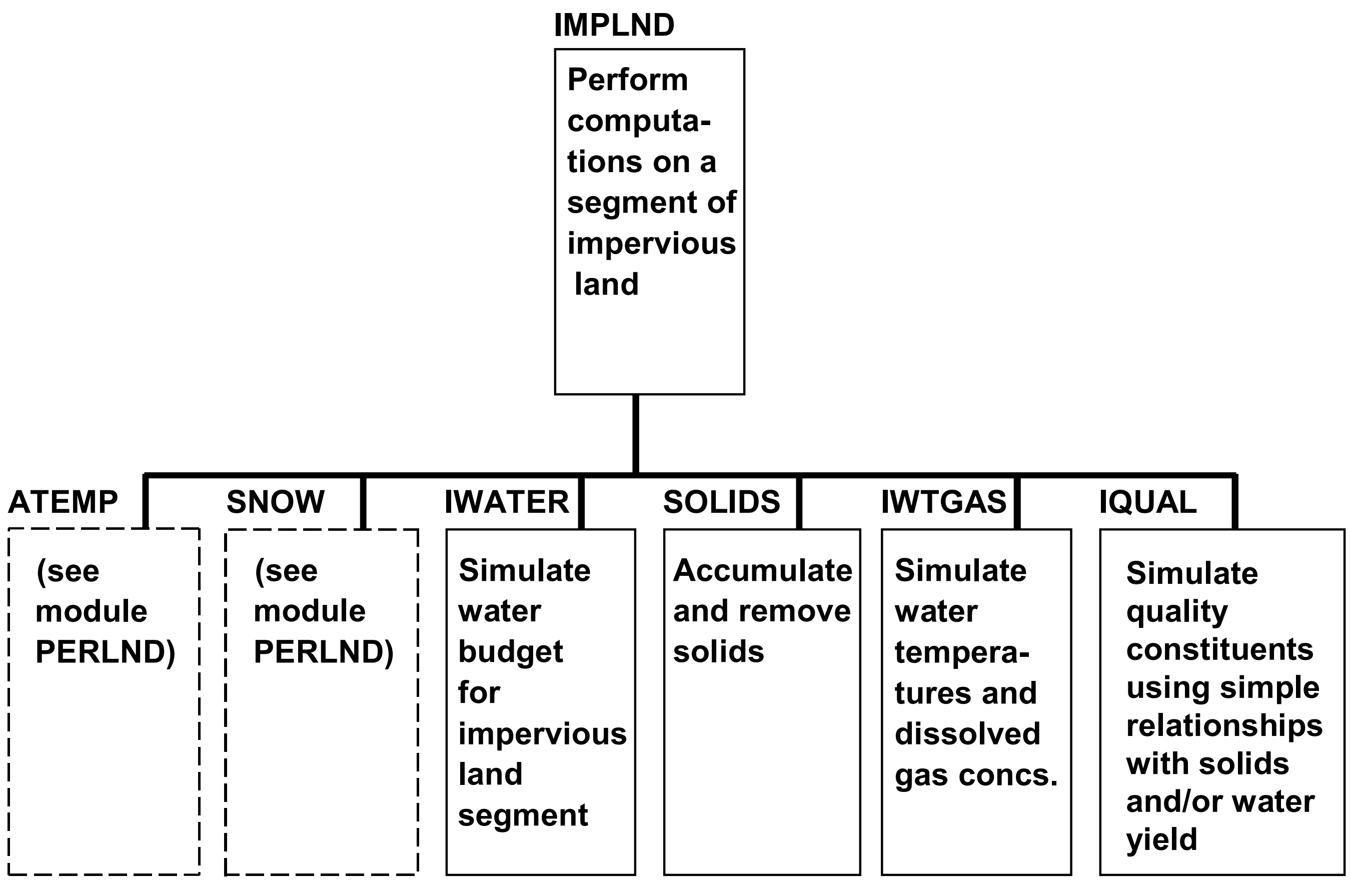

Figure 2 IMPLND Structure Chart

and contents of the IMPLND module. The module shares much of its code with PERLND, but is simplified since infiltration and other interactions with the subsurface cannot occur. The module features individual compartments for modeling air temperature as a function of elevation (ATEMP), snow accumulation and melting (SNOW), hydrologic water budget (IWATER), solids accumulation and removal (SOLIDS), surface runoff water temperature and gas concentrations (IWTGAS), and generalized water quality constituents (IQUAL).

One difference between PERLND and IMPLND process representation is of note. In the SOLIDS code section, IMPLND offers the capability to model the accumulation and removal of urban solids (i.e., solids on impervious areas) by processes that are independent of storm events (e.g., street cleaning, decay, wind deposition or scour). To use this option, the modeler needs to assign monthly or constant rates of solids accumulation and removal, estimate parameter values for impervious solids washoff (analogous to methods in the SEDMNT module of PERLND), and provide 'potency factor' values for constituents associated with the solids removed. Alternatively, the IQUAL module can be used to represent accumulation and removal processes for each constituent individually, analogous to the PQUAL approach.

RCHRES Module

RCHRES is used to route runoff and water quality constituents simulated by PERLND and IMPLND through stream channel networks and reservoirs. The module simulates the processes that occur in a series of open or closed channel reaches or a completely mixed lake. Flow is modeled as unidirectional. A number of processes can be modeled, including the following:

- Hydraulic behavior.
- Heat balance processes that determine water temperature.
- Inorganic sediment deposition, scour, and transport by particle size.
- Chemical partitioning, hydrolysis, volatilization, oxidation, biodegradation, and generalized first-order (e.g., radionuclides) decay, parent chemical/metabolite transformations.
- DO and BOD balances.
- Inorganic nitrogen and phosphorus balances.
- Plankton populations.
- pH, carbon dioxide, total inorganic carbon, and alkalinity.

Figure 3 defines the structure and contents of the RCHRES module. The module features individual compartments for modeling hydraulics (HYDR), constituent advection (ADCALC), conservatives (CONS), water temperature (HTRCH), inorganic sediment (SEDTRN), generalized quality

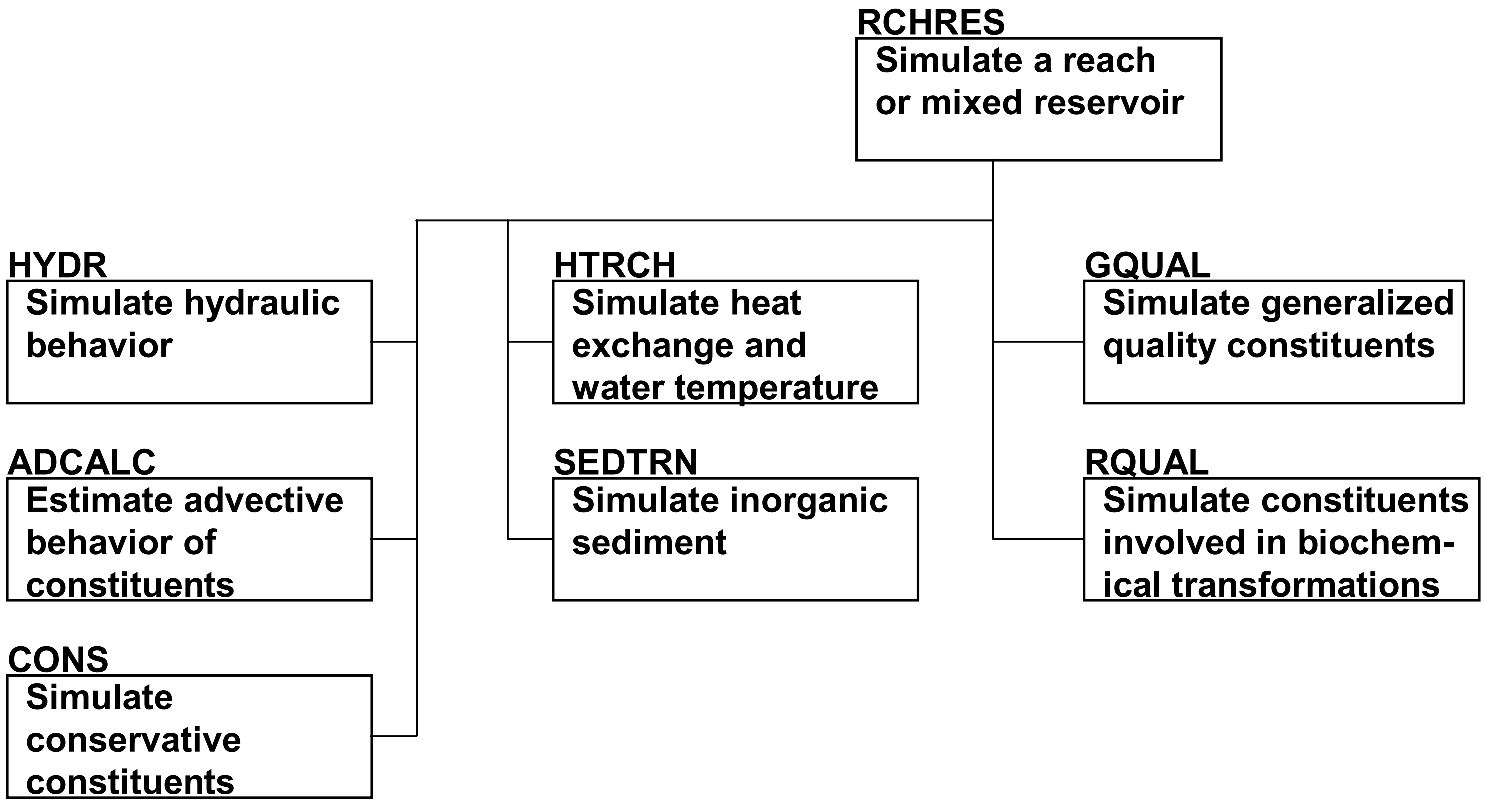

Figure 3 RCHRES Structure Chart

constituents (GQUAL), specific constituents involved in biochemical transformations (RQUAL), and acid mine drainage phenomena (ACIDPH).

HYDR simulates the processes that occur in a single reach of an open channel or a completely mixed lake. Hydraulic behavior is modeled using the kinematic wave assumption. All inflows to a reach are assumed to enter at a single upstream point. The outflow of a reach may be distributed across several targets that might represent normal outflows, diversions, and multiple gates of a reservoir. In HSPF, outflows can be represented by either, or both, of two methods:

1) Outflow can be modeled as a function of reach volume for situations where there is no control of flows, or gate settings are only a function of water level.

2) Outflow can be modeled as a function of time to represent demands for municipal, industrial, or agricultural use. To do so, the modeler must provide a time series of outflow values for the outflow target that is time-dependent and independent of reach volume.

If an outflow demand has both volume-dependent and time-dependent components, the modeler can, and must, specify how the components are combined to define the resulting outflow demand. HSPF allows the modeler to define the resulting demand in one of three manners: (1) as the minimum of the two components, (2) as the maximum of the two components, or (3) as the sum of the two components.

HSPF makes no assumptions regarding the shape of a reach; however, the following assumptions are made:

1) There is a fixed, user-defined relation between water depth, surface area, volume, and discharge. This is specified in a Function Table (FTABLE) defined for each reach by the user.

2) For any outflow demand with a volume-dependent component, the relation between the above variables is usually constant in time; however, predetermined seasonal or daily variations in discharge values can be represented by the user.

These assumptions rule out cases where flow reverses direction (e.g., estuaries) or where one stream reach influences another upstream of it in a time-dependent manner. Momentum is not considered, and the routing technique falls in the class known as "storage routing" or "kinematic wave" methods.

In addition to calculating outflow rates and reach water volumes, HYDR computes the values for additional hydraulic parameters that are used in the other code sections of RCHRES including depth, stage, surface area, average depth, top width, hydraulic radius, bed shear stress and shear velocity.

The approach taken by the SEDTRN code compartment to compute transport of channel sediment is based on the SERATRA model developed by Battelle Laboratories (Onishi and Wise, 1979). Both noncohesive (sand) and cohesive (silt, clay) sediments are simulated in SEDTRN; migration of each sediment fraction between suspension in water and the bed is modeled by balancing deposition and scour computations. The code allows the modeler to compute the deposition or scour of noncohesive sediment by selecting one of three empirical formulations:

1) A user-defined power function of streamflow velocity.

2) A relationship (Toffaleti method) dependent upon median sand particle diameter, average stream velocity, reach hydraulic radius, reach slope, settling velocity for sand (user-specified), and water temperature.

3) A relationship (Colby method) dependent upon median sand particle diameter, average stream velocity, reach hydraulic radius, fine sediment load concentration, and water temperature.

The simulation of cohesive sediment transport consists of two steps. First, advective transport is calculated; then deposition and scour are calculated based on the calculated bed shear stress. To evaluate deposition, the modeler is required to provide values for settling velocity and critical shear stress for deposition for each fraction (silt, clay) of cohesive sediment that is modeled. To evaluate resuspension, or scour, the modeler must provide values for the erodibility coefficient and critical shear stress for each fraction.

The focus of the GQUAL code development was to allow simulation of agricultural pesticides and other synthetic organic chemicals. Given the diversity of pesticides that might be modeled, the code provides the user with the capability to model any subset of the following generalized processes: advection of dissolved material; decay of dissolved material by hydrolysis, oxidation by free radical oxygen, photolysis, volatilization, biodegradation, and/or generalized first-order decay; production of one modeled constituent as a result of decay of another constituent; advection of adsorbed suspended material; deposition and scour of adsorbed material; and adsorption/desorption between dissolved and sediment-associated phases. Using the GQUAL section in conjunction with the sediment transport code (SEDTRN), adsorbed chemicals may settle or resuspend during each simulation time step, depending on hydrodynamic conditions. Decomposition of adsorbed chemicals may be simulated, both in suspended materials and in the bed, by using a first-order, temperature-corrected decay formulation.

The RQUAL code provides detailed simulation of constituents involved in biochemical transformations. Included are dissolved oxygen, BOD, ammonia, nitrite, nitrate, phosphate, phytoplankton, benthic algae, zooplankton, refractory organics, and pH. The primary dissolved oxygen and biochemical oxygen demand balances are simulated with provisions for decay, settling, benthic sinks and sources, reaeration, and sinks and sources related to plankton. The primary nitrogen balance is modeled as sequential reactions from ammonia through nitrate. Ammonia volatilization, ammonification, denitrification, and ammonium adsorption/desorption interactions with suspended sediment fractions are also considered. Both ammonium and phosphate adsorption/desorption to suspended sediment fractions are modeled using an equilibrium, linear isotherm approach. Both nitrogen and phosphorus species are considered in modeling three types of plankton—phytoplankton, attached algae, and zooplankton. Phytoplankton processes that are modeled include growth, respiration, sinking, zooplankton predation, and death; zooplankton processes include growth, respiration and death; and benthic algae processes modeled are growth, respiration, and death. Hydrogen ion activity (pH) can be calculated by two independent code sections. The first, named PHCARB, is contained within the RQUAL section and computes pH by considering carbon dioxide, total organic carbon, and alkalinity. In doing so, the code considers the effects on the carbon dioxide-bicarbonate system of carbon dioxide invasion, zooplankton respiration, BOD decay, net growth of algae, and benthic releases.

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APPENDIX B.2

HSPF PARAMETER LIST FOR PERLND, IMPLND & RCHRES MODULES

HSPF Parameter List for PERLND, IMPLND, & RCHRES Modules

PERLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
ATEMP				
AIRTMP	Initial air temperature over the Pervious Land Segment	Deg F	ATEMP-DAT	Site
ELDAT	Difference in elevation between temp gage and the Pervious Land Segment	ft	ATEMP-DAT	Site
PERLND				
AIRTFG	Flag to specify if section ATEMP is active (1) or inactive (0)	N/A	ACTIVITY	Option
IUNITS	Units in input time series--1=English, 2=metric	N/A	GEN-INFO	Option
LSID(5)	Identifier for a Pervious Land Segment	N/A	GEN-INFO	Option
MSTLFG	Flag to specify if section MSTLAY is active (1) or inactive (0)	N/A	ACTIVITY	Option
NBLKS	No. of "blocks" into which the Pervious Land Segment is subdivided	N/A	GEN-INFO	Option
NITRFG	Flag to specify if section NITR is active (1) or inactive (0)	N/A	ACTIVITY	Option
OUNITS	Units in output time series--1=English, 2=metric	N/A	GEN-INFO	Option
PESTFG	Flag to specify if section PEST is active (1) or inactive (0)	N/A	ACTIVITY	Option
PFLAG(12)	Printout level	N/A	PRINT-INFO	Option
PHOSFG	Flag to specify if section PHOS is active (1) or inactive (0)	N/A	ACTIVITY	Option
PIVL	Number of intervals between level 2 printouts	N/A	PRINT-INFO	Option
PQALFG	Flag to specify if section PQUAL is active (1) or inactive (0)	N/A	ACTIVITY	Option
PSTFG	Flag to specify if section PSTEMP is active (1) or inactive (0)	N/A	ACTIVITY	Option
PUNIT(2)	Fortran output unit for English and/or metric units. 0=none for that system.	N/A	GEN-INFO	Option
PWATFG	Flag to specify if section PWATER is active (1) or inactive (0)	N/A	ACTIVITY	Option
PWGFG	Flag to specify if section PWTGAS is active (1) or inactive (0)	N/A	ACTIVITY	Option
PYREND	Calendar month of end of year	N/A	PRINT-INFO	Option

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

PERLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
SEDFG	Flag to specify if section SEDMNT is active (1) or inactive (0)	N/A	ACTIVITY	Option
SNOWFG	Flag to specify if section SNOW is active (1) or inactive (0)	N/A	ACTIVITY	Option
TRACFG	Flag to specify if section TRACER is active (1) or inactive (0)	N/A	ACTIVITY	Option
UUNITS	Units in UCI--1=English, 2=Metric	N/A	GEN-INFO	Option
PQUAL				
ACQOP	Rate of accumulation of QUALOF (overland flow-associated constituent)	lbs/ac.day	QUAL-INPUT	Literature/Site/Calib.
ACQOPM(12)	Monthly accumulation rates of QUALOF (overland flow-associated constituent)	lbs/ac.day	MON-ACCUM	Literature/Site/Calib.
AOQC	Concentration of the constituent in active groundwater outflow (meaningful only if this is a QUALGW (active groundwater-associated constituent))	mg/l	QUAL-INPUT	Site
AOQCM(12)	Monthly conc of QUAL in groundwater if VAQCFG = 3 or 4	mg/l	MON-GRND-CONC	Site/Calib.
AOQCM(12)	Monthly conc of QUAL in groundwater if VAQCFG = 1 or 2	lbs/ft3	MON-GRND-CONC	Site/Calib.
IOQC	Concentration of the constituent in interflow outflow (meaningful only if this is a QUALIF (interflow-associated constituent))	lbs/ft3	QUAL-INPUT	Site/Calib.
IOQCM(12)	Monthly conc of QUAL in interflow if VIQCFG = 1 or 2	lbs/ft3	MON-IFLW-CONC	Site/Calib.
IOQCM(12)	Monthly conc of QUAL in interflow if VIQCFG = 3 or 4	mg/L	MON-IFLW-CONC	Site/Calib.
NQUAL	Total number of quality constituents simulated	N/A	NQUALS	Option
POTFS	Scour potency factor	lbs/ton	QUAL-INPUT	Literature/Site/Calib.
POTFSM(12)	Monthly scour potency factor	lbs/ton	MON-POTFS	Literature/Site/Calib.
POTFW	Washoff potency factor	lbs/ton	QUAL-INPUT	Literature/Site/Calib.
POTFWM(12)	Monthly washoff potency factor	lbs/ton	MON-POTFW	Literature/Site/Calib.
QAGWFG	Flag to specify if constituent is groundwater associated; 1=yes, 0=no	N/A	QUAL-PROPS	Literature/Site
QIFWFG	Flag to specify if constituent is interflow associated; 1=yes, 0=no	N/A	QUAL-PROPS	Literature/Site
QSDFG	Flag to specify if constituent is sediment associated; 1=yes, 0=no	N/A	QUAL-PROPS	Literature/Site
QSOFG	Flag to specify if constituent is directly associated with overland flow; 1=yes, 0=no	N/A	QUAL-PROPS	Literature/Site

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES (Continued)

PERLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
QTYID	String of up to 4 chars identifying units of quality constituent	N/A	QUAL-PROPS	Option
QUALID	String identifying the quality constituent	N/A	QUAL-PROPS	
SQO	Initial storage of QUALOF (overland flow-associated constituent) on the surface of the Pervious Land Segment	lbs/ac	QUAL-INPUT	Literature/Site
SQOLIM	Maximum storage of QUALOF (overland flow-associated constituent)	lbs/ac	QUAL-INPUT	Literature/Site/Calib.
SQOLIM(12)	Monthly limiting storage of QUALOF (overland flow-associated constituent)	lbs/ac	MON-SQOLIM	Literature/Site/Calib.
VAQCFG	If 1, concentration of constituent in groundwater outflow varies monthly; if 2 or 4, daily values are obtained directly from monthly values without interpolation between monthly values; if 3 or 4, the units of input concentrations are mg/L	N/A	QUAL-PROPS	Literature/Site
VIQCFG	If greater than 1, concentration of constituent in interflow outflow varies monthly: if 2 or 4, daily values are obtained directly from monthly values without interpolation between monthly values; if 3 or 4, units of input concentrations are mg/L	N/A	QUAL-PROPS	Literature/Site
VPFSFG	Flag to specify if scour potency factor varies monthly; 1=yes, 0=no	N/A	QUAL-PROPS	Literature/Site
VPFWFG	If 1, washoff potency factor varies monthly; if 2, daily factors are <u>not</u> computed by interpolation between the monthly values; if 0, factor does not vary	N/A	QUAL-PROPS	Literature/Site
VQOFG	Flag to specify if rate of accumulation and limiting storage of constituent varies monthly; 1=yes, 0=no	N/A	QUAL-PROPS	Literature/Site
WSQOP	Rate of surface runoff which will remove 90 percent of stored QUALOF (overland flow-associated constituent) per hour	in/hr	QUAL-INPUT	Literature/Site/Calib.
PSTEMP				
AIRTC	Initial air temperature	deg F	PSTEMP-TEMPS	Site
ASLT	Intercept of the surface layer temperature regression equation	deg F	PSTEMP-PARM2	Literature/Site/Calib.
ASLTM(12)	Monthly values for ASLT	deg F	MON-ASLT	Literature/Site/Calib.

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

PERLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
BSLT	Slope of the surface layer temperature regression equation	deg F	PSTEMP-PARM2	Literature/Site/Calib.
BSLTM(12)	Monthly values for BSLT	deg F	MON-BSLT	Literature/Site/Calib.
LGTMP	Initial lower layer/groundwater layer soil temperature	deg F	PSTEMP-TEMPS	Literature/Site
LGTP1	The smoothing factor for calculating lower layer/groundwater soil temperature if TSOPFG = 0	N/A	PSTEMP-PARM2	Literature/Calib.
LGTP1	The lower layer/groundwater layer soil temperature if TSOPFG = 1	N/A	PSTEMP-PARM2	Literature/Calib.
LGTP1M(12)	Monthly values for LGTP1	see above	MON-LGTP1	Literature/Calib.
LGTP2	Not used if TSOPFG = 1	N/A	PSTEMP-PARM2	Literature/Calib.
LGTP2	The mean departure from air temperature for calculating lower layer/groundwater soil temperature if TSOPFG = 0	deg F	PSTEMP-PARM2	Literature/Calib.
LGTP2M(12)	Monthly values for LGTP2	see above	MON-LGTP2	Literature/Calib.
LGTVFG	Flag to specify if parameters for estimating lower layer temperature vary monthly; 1=yes, 0=no	N/A	PSTEMP-PARM1	Site
SLTMP	Initial surface layer soil temperature	deg F	PSTEMP-TEMPS	Site
SLTVFG	Flag to specify if parameters for estimating surface layer temperature vary monthly; 1=yes, 0=no	N/A	PSTEMP-PARM1	Literature/Site
TSOPFG	Governs the methods used to estimate subsurface soil temperatures - if 0, use mean departure from air temperature with smoothing factors; if 1 upper layer temp is estimated by regression on air temperature and lower/groundwater layers temp supplied by user	N/A	PSTEMP-PARM1	Literature/Site
ULTMP	Initial upper layer soil temperature	deg F	PSTEMP-TEMPS	Site
ULTP1	The smoothing factor in upper layer temperature calculation if TSOPFG = 0	N/A	PSTEMP-PARM2	Literature/Site/Calib.
ULTP1	The intercept in the upper layer soil temperature regression equation if TSOPFG = 1	deg F	PSTEMP-PARM2	Literature/Site/Calib.
ULTP1M(12)	Monthly values for ULTP1	see above	MON-ULTP1	Literature/Site/Calib.
ULTP2	The mean difference between upper layer soil temperature and air temperature if TSOPFG = 0	deg F	PSTEMP-PARM2	Literature/Calib.

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES (Continued)

PERLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
ULTP2	The slope in the upper layer soil temperature regression equation if TSOPFG = 1	deg F/F	PSTEMP-PARM2	Literature/Calib.
ULTP2M(12)	Monthly values for ULTP2	see above	MON-ULTP2	Literature/Calib.
ULTVFG	Flag to specify if parameters for estimating upper layer temperature vary monthly; 1=yes, 0=no	N/A	PSTEMP-PARM1	Literature/Site
PWATER				
AGWETP	Fraction of remaining potential E-T which can be satisfied from active groundwater storage if enough is available	N/A	PWAT-PARM3	Literature/Site/Calib.
AGWRC	Basic groundwater recession rate if KVARY is zero and there is no inflow to groundwater (rate of flow today/rate yesterday)	1/day	PWAT-PARM2	Literature/Site/Calib.
AGWS	Active groundwater storage	inches	PWAT-STATE1	Literature/Site/Calib.
BASETP	Fraction of remaining potential E-T which can be satisfied from baseflow if enough is available	N/A	PWAT-PARM3	Literature/Site/Calib.
CEPS	Interception storage	inches	PWAT-STATE1	Site
CEPSC	Interception storage capacity	in	PWAT-PARM4	Literature/Site/Calib.
CEPSCM(12)	Monthly interception storage capacity	in	MON-INTERCEP	Literature/Site/Calib.
CSNOFG	Flag to specify if snow is considered; 1=yes, 0=no	N/A	PWAT-PARM1	Site
DEEPFR	Fraction of groundwater inflow which will enter deep (inactive) groundwater and, thus, be lost from the system	N/A	PWAT-PARM3	Literature/Site/Calib.
FOREST	Fraction of the Pervious Land Segment which is covered by forest which will continue to transpire in winter	N/A	PWAT-PARM2	Site
GWVS	Index to groundwater slope; it is a measure of antecedent active groundwater inflow	inches	PWAT-STATE1	Site/Calib.
IFWS	Interflow storage	inches	PWAT-STATE1	Site/Calib.
INFEXP	Exponent in the infiltration equation	N/A	PWAT-PARM3	Literature/Calib.
INFILD	Ratio between the max and mean infiltration capacities over the Pervious Land Segment	N/A	PWAT-PARM3	Literature/Calib.
INFILT	Index to the infiltration capacity of the soil	in/hr	PWAT-PARM2	Literature/Site/Calib.
INTFW	Interflow inflow parameter	N/A	PWAT-PARM4	Literature/Site/Calib.
INTFWM(12)	Monthly interflow inflow parameters	N/A	MON-INTERFLW	Literature/Site/Calib.

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

PERLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
IRC	Interflow recession parm. Under zero inflow, this is the ratio of interflow outflow rate today/rate yesterday	1/day	PWAT-PARM4	Literature/Site/Calib.
IRCM(12)	Monthly interflow recession constants	/day	MON-IRC	Literature/Site/Calib.
KVARY	Parameter which affects the behavior of groundwater recession flow, enabling it to be non-exponential in its decay with time	1/in	PWAT-PARM2	Literature/Site/Calib.
LSUR	Length of the assumed overland flow plane	ft	PWAT-PARM2	Site
LZETP	Lower zone E-T parm; an index to the density of deep-rooted vegetation	N/A	PWAT-PARM4	Literature/Site/Calib.
LZETPM(12)	Monthly lower zone E-T parameter	N/A	MON-LZETPARM	Literature/Site/Calib.
LZS	Lower zone storage	inches	PWAT-STATE1	Site
LZSN	Lower zone nominal storage	in	PWAT-PARM2	Literature/Site/Calib.
NSUR	Manning's n for the assumed overland flow plane	N/A	PWAT-PARM4	Literature/Site
NSURM(12)	Monthly Manning's n values	complex	MON-MANNING	Literature/Site
PETMAX	Air temp below which E-T will arbitrarily be reduced below the value obtained from the input time series	degF	PWAT-PARM3	Literature/Site
PETMIN	Temp below which E-T will be zero regardless of the value in the input time series	degF	PWAT-PARM3	Literature/Site
RTOPFG	Flag to specify if overland flow is routed by HSPX method instead of new method; 1=HSPX method, 0=new method	N/A	PWAT-PARM1	Literature/Site
SLSUR	Slope of the assumed overland flow plane	N/A	PWAT-PARM2	Site
SURS	Surface (overland flow) storage	inches	PWAT-STATE1	Literature/Site
UZFG	Flag to specify if upper zone inflow is computed by HSPX method instead of new method; 1=HSPX method, 0=new method	N/A	PWAT-PARM1	Literature/Site
UZS	Upper zone storage	inches	PWAT-STATE1	Literature/Site
UZSN	Upper zone nominal storage	in	PWAT-PARM4	Literature/Site/Calib.
UZSNM(12)	Monthly upper zone storage	in	MON-UZSN	Literature/Site/Calib.
VCSFG	Flag to specify if interception storage capacity varies monthly; 1=yes, 0=no	N/A	PWAT-PARM1	Site
VIFWFG	Flag to specify if interflow inflow parameter varies monthly; 1=yes, 0=no	N/A	PWAT-PARM1	Site
VIRCFG	Flag to specify if interflow recession constant varies monthly; 1=yes, 0=no	N/A	PWAT-PARM1	Site
VLEFG	Flag to specify if lower zone E-T parameter varies monthly; 1=yes, 0=no	N/A	PWAT-PARM1	Literature/Site

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

PERLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
VNNFG	Flag to specify if Manning's n varies monthly; 1=yes, 0=no	N/A	PWAT-PARM1	Literature/Site
VUZFG	Flag to specify if upper zone nominal storage varies monthly; 1=yes, 0=no	N/A	PWAT-PARM1	Literature/Site
PWTGAS				
ACO2P	Concentration of dissolved CO2 in active groundwater outflow	mg	PWT-PARM2	Literature/Site
ACO2PM(12)	Monthly groundwater CO2 concentration	mg	MON-GRNDCO2	Literature/Site
ADOXP	Concentration of dissolved oxygen in active groundwater outflow	mg/l	PWT-PARM2	Literature/Site
ADOXPM(12)	Monthly groundwater DO concentration	mg/l	MON-GRNDDOX	Literature/Site
AOCO2	Initial CO2 concentration in active groundwater outflow	mg	PWT-GASES	Site
AODOX	Initial DO concentration in active groundwater outflow	mg/l	PWT-GASES	Site
AOTMP	Initial active groundwater outflow temperature	deg F	PWT-TEMPS	Site
ELEV	Elevation of the Pervious Land Segment above sea level	ft	PWT-PARM2	Site
GCVFG	Flag to specify if groundwater CO2 concentration varies monthly; 1=yes, 0=no	N/A	PWT-PARM1	Site
GDVFG	Flag to specify if groundwater DO concentration varies monthly; 1=yes, 0=no	N/A	PWT-PARM1	Site
ICO2P	Concentration of dissolved CO2 in interflow outflow	mg	PWT-PARM2	Literature/Site/Calib.
ICO2PM(12)	Monthly interflow CO2 concentration	mg	MON-IFWCO2	Literature/Site/Calib.
ICVFG	Flag to specify if interflow CO2 concentration varies monthly; 1=yes, 0=no	N/A	PWT-PARM1	Site
IDOXP	Concentration of dissolved oxygen in interflow outflow	mg/l	PWT-PARM2	Literature/Site/Calib.
IDOXPM(12)	Monthly interflow DO concentration	mg/l	MON-IFWDOX	Literature/Site/Calib.
IDVFG	Flag to specify if interflow DO concentration varies monthly; 1=yes, 0=no	N/A	PWT-PARM1	Site
IOCO2	Initial CO2 concentration in interflow outflow	mg	PWT-GASES	Site
IODOX	Initial DO concentration in interflow outflow	mg/l	PWT-GASES	Site
IOTMP	Initial interflow outflow temperature	deg F	PWT-TEMPS	Site
SOCO2	Initial CO2 concentration in surface outflow	mg/l	PWT-GASES	Site
SODOX	Initial DO concentration in surface outflow	mg/l	PWT-GASES	Site
SOTMP	Initial surface outflow temperature	deg F	PWT-TEMPS	Site
SEDMNT				
AFFIX	Fraction by which detached sediment storage decreases each day, as a result of soil compaction	/day	SED-PARM2	Literature/Site/Calib.

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

PERLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
COVER	Fraction of land surface which is shielded from erosion by rainfall (not considering snow cover, which can be handled by simulation)	N/A	SED-PARM2	Literature/Site
COVERM(12)	Monthly erosion related cover values	N/A	MON-COVER	Literature/Site
CRVFG	Flag to specify if erosion-related cover varies monthly; 1=yes, 0=no	N/A	SED-PARM1	Site
DETS	Initial storage of detached sediment	tons/ac	SED-STOR	Literature/Site
JGER	Exponent in the matrix soil scour equation (simulates gully erosion, etc)	complex	SED-PARM3	Literature/Site/Calib.
JRER	Exponent in the soil detachment equation	N/A	SED-PARM2	Literature/Site/Calib.
JSER	Exponent in the detached sediment washoff equation	complex	SED-PARM3	Literature/Site/Calib.
KGER	Coefficient in the matrix soil scour equation (simulates gully erosion, etc)	complex	SED-PARM3	Literature/Site/Calib.
KRER	Coefficient in the soil detachment equation	N/A	SED-PARM2	Literature/Site/Calib.
KSER	Coefficient in the detached sediment washoff equation	complex	SED-PARM3	Literature/Site/Calib.
NVSI	Rate at which sediment enters detached storage from the atmosphere; a negative value can be supplied (eg, to simulate removal by human activity or wind)	lb/ac.day	SED-PARM2	Literature/Site
NVSIM(12)	Monthly net vertical sediment input	lb/ac.day	MON-NVSI	Literature/Site
SDOPFG	Flag to specify if removal of sediment from land surface is computed by ARM and NPS method instead of new method; 1=ARM and NPS method, 0=new method	N/A	SED-PARM1	Option
SMPF	"Supporting management practice factor" used to simulate the reduction in erosion achieved by use of erosion control practices	N/A	SED-PARM2	Literature/Site
VSIVFG	Flag to specify if the rate of net vertical sediment input varies monthly; 1=yes, 0=no If 2, vertical sediment input is added to the detached sediment storage only on days when no rainfall occurred during the previous day	N/A	SED-PARM1	Site
SNOW				
CCFACT	Parameter to adapt the snow condensation/convection melt equation to field conditions	N/A	SNOW-PARM2	Literature/Calib.

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

PERLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
COVIND	Maximum pack (water equivalent) at which the entire Pervious Land Segment will be covered with snow	in	SNOW-PARM1	Literature/Site
COVINX	Current pack (water equiv) required to obtain complete areal coverage of the Pervious Land Segment	in	SNOW-INIT2	Literature/Site
DULL	Index to the dullness of the pack surface, from which albedo is estimated	N/A	SNOW-INIT1	Literature/Site
ICEFG	Flag to specify if ice formation in snow pack will be simulated; 1=yes, 0=no	N/A	ICE-FLAG	Literature/Site
LAT	Latitude of the Pervious Land Segment	degrees	SNOW-PARM1	Site
MELEV	Mean elevation of the Pervious Land Segment	ft	SNOW-PARM1	Site
MGMELT	Max rate of snowmelt by ground heat	in/day	SNOW-PARM2	Literature/Site/Calib.
MWATER	Max water content of the snow pack, in depth water per depth water equiv	N/A	SNOW-PARM2	Literature/Site/Calib.
Pack-ice	Quantity of ice in the pack (water equiv)	in	SNOW-INIT1	Literature/Site
Pack-snow	Quantity of snow in the pack (water equiv)	in	SNOW-INIT1	Literature/Site
Pack-watr	Quantity of liquid water in the pack	in	SNOW-INIT1	Literature/Site
PAKTMP	Mean temperature of the frozen contents of the pack	degF	SNOW-INIT1	Literature/Site
RDCSN	Density of cold, new snow relative to water	N/A	SNOW-PARM2	Literature/Site
RDENPF	Density of the frozen contents (snow+ice) of the pack, relative to water	N/A	SNOW-INIT1	Literature/Site
SHADE	Fraction of the Pervious Land Segment shaded from solar radiation, e.g. by trees	N/A	SNOW-PARM1	Literature/Site
SKYCLR	Fraction of sky which is clear	N/A	SNOW-INIT2	Literature/Site
SNOEVP	Parameter to adapt the snow evaporation equation to field conditions	N/A	SNOW-PARM2	Literature/Site
SNOWCF	Factor by which recorded snowfall data is multiplied to account for poor snow catch efficiency	N/A	SNOW-PARM1	Literature/Site/Calib.
TSNOW	Air temp below which precip will be snow, under saturated conditions	degF	SNOW-PARM2	Literature/Calib.
XLNMLT	Current remaining possible increment to ice storage in the pack	in	SNOW-INIT2	Literature/Site

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

IMPLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
ATEMP				
AIRTMP	Initial air temperature over the ILS	Deg F	ATEMP-DAT	Site
ELDAT	difference in elevation between temp gage and the ILS	ft	ATEMP-DAT	Site
IMPLND				
AIRTFG	Flag to specify if section ATEMP is active (1) or inactive (0)	N/A	ACTIVITY	Option
IQALFG	Flag to specify if section PQUAL is active (1) or inactive (0)	N/A	ACTIVITY	Option
IUNITS	Units in input time series--1=English, 2=Metric	N/A	GEN-INFO	Option
IWATFG	Flag to specify if section IWATER is active (1) or inactive (0)	N/A	ACTIVITY	Option
IWGFG	Flag to specify if section IWTGAS is active (1) or inactive (0)	N/A	ACTIVITY	Option
LSID(5)	Identifier for an ILS	N/A	GEN-INFO	
OUNITS	Units in output time series--1=English, 2=Metric	N/A	GEN-INFO	Option
PFLAG(6)	Printout level	N/A	PRINT-INFO	Option
PIVL	Number of intervals between level 2 printouts	N/A	PRINT-INFO	Option
PUNIT(2)	Fortran output unit for English and/or Metric units. 0=none for that system.	N/A	GEN-INFO	Option
PYREND	Calendar month of end of year	N/A	PRINT-INFO	Option
SLDFG	Flag to specify if section SOLIDS is active (1) or inactive (0)	N/A	ACTIVITY	Option
SNOWFG	Flag to specify if section SNOW is active (1) or inactive (0)	N/A	ACTIVITY	Option/Site
UUNITS	Units in UCI--1=English, 2=Metric	N/A	GEN-INFO	Option
IQUAL				
ACQOP	Rate of accumulation of QUALOF (overland flow-associated constituent)	qty/ac.day	QUAL-INPUT	Literature/Calib.
ACQOPM(12)	Monthly accumulation rates of QUALOF (overland flow-associated constituent)	qty/ac.day	MON-ACCUM	Literature/Calib.
NQUAL	Total number of quality constitutents simulated	N/A	NQUALS	Option
POTFW	Washoff potency factor	qty/ton	QUAL-INPUT	Literature/Site/Calib.

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

IMPLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
POTFWM(12)	Monthly washoff potency factor	qty/ton	MON-POTFW	Literature/Site/Calib.
QSDFG	Flag to specify if constituent is sediment associated; 1=yes, 0=no	N/A	QUAL-PROPS	Literature/Site/Calib.
QSOFG	Flag to specify if constituent is directly associated with overland flow; 1=yes, 0=no	N/A	QUAL-PROPS	Literature/Site
QTYID	String of up to 4 chars identifying units of quality constituent	N/A	QUAL-PROPS	
QUALID	String identifying the quality constituent	N/A	QUAL-PROPS	
SQO	Initial storage of QUALOF (overland flow-associated constituent) on surface	qty/ac	QUAL-INPUT	Literature/Site/Calib.
SQOLIM	Maximum storage of QUALOF (overland flow-associated constituent)	qty/ac	QUAL-INPUT	Literature/Site/Calib.
SQOLIM(12)	Monthly limiting storage of QUALOF (overland flow-associated constituent)	qty/ac	MON-SQOLIM	Literature/Site/Calib.
VPFWFG	Flag to specify if washoff potency factor varies monthly; 1=yes, 0=no	N/A	QUAL-PROPS	Option
VQOFG	Flag to specify if rate of accumulation and limiting storage of constituent varies monthly; 1=yes, 0=no	N/A	QUAL-PROPS	Option
WSQOP	Rate of surface runoff which will remove 90 percent of stored QUALOF (overland flow-associated constituent) per hour	in/hr	QUAL-INPUT	Literature/Calib.
IWATER				
ACCSDM(12)	Monthly solids accumulation rates	tons/ac.day	MON-SACCUM	Literature/Calib.
ACCSDP	Rate at which solids are placed on the land surface	tons/ac.day	SLD-PARM2	Literature/Calib.
CSNOFG	Flag to specify if snow is considered; 1=yes, 0=no	N/A	IWAT-PARM1	Option/Site
JEIM	Exponent in the solids washoff equation	complex	SLD-PARM2	Literature
KEIM	Coefficient in the solids washoff equation	complex	SLD-PARM2	Literature/Calib.
LSUR	Length of the assumed overland flow plane	ft	IWAT-PARM2	Site
NSUR	Manning's n for the overland flow plane	N/A	IWAT-PARM2	Literature/Site
NSURM(12)	Monthly Manning's n values	complex	MON-MANNING	Literature/Site
PETMAX	Air temp below which E-T will arbitrarily be reduced below the value obtained from the input time series	degF	IWAT-PARM3	Literature/Site
PETMIN	Air temp below which E-T will be zero regardless of the value in the input time series	degF	IWAT-PARM3	Literature/Site
REMSDM(12)	Monthly solids unit removal rates	/day	MON-REMOV	Literature/Calib.

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES (Continued)

IMPLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
REMSDP	Fraction of solids storage which is removed each day; when there is no runoff, for example, because of street sweeping	/day	SLD-PARM2	Literature/Site
RETS	Retention storage	inches	IWAT-STATE1	Literature/Site
RETSC	Retention (interception) storage capacity of the surface	in	IWAT-PARM2	Literature/Site
RETSCM(12)	Monthly retention storage capacity	in	MON-RETN	Option
RTLIFG	Flag to specify if lateral surface inflow to the ILS is subject to retention storage; 1=yes, 0=no	N/A	IWAT-PARM1	Option
RTOPFG	Flag to specify if overland flow is routed by HSPX method instead of new method; 1=HSPX method, 0=new method	N/A	IWAT-PARM1	Option
SDOPFG	Flag to specify if removal of sediment from land surface is computed by ARM and NPS method instead of new method; 1=ARM and NPS method, 0=new method	N/A	SLD-PARM1	Option
SLDS	Initial storage of solids	tons/ac	SLD-STOR	Literature/Site
SLSUR	Slope of the assumed overland flow plane	N/A	IWAT-PARM2	Site
SURS	Surface (overland flow) storage	inches	IWAT-STATE1	Literature/Site
VASDFG	Flag to specify if accumulation rate of solids varies monthly; 1=yes, 0=no	N/A	SLD-PARM1	Option
VNNFG	Flag to specify if Manning's n varies monthly; 1=yes, 0=no	N/A	IWAT-PARM1	Option
VRSDFG	Flag to specify if unit removal rate of solids varies monthly; 1=yes, 0=no	N/A	SLD-PARM1	Option
VRSFG	Flag to specify if retention storage capacity varies monthly; 1=yes, 0=no	N/A	IWAT-PARM1	Option
IWTGAS				
AWTF	Intercept of surface water temperature regression equation	DegF	IWT-PARM2	Literature/Site/Calib.
AWTFM(12)	Monthly values for AWTF	deg F	MON-AWTF	Literature/Site/Calib.
BWTF	Slope of the surface water temperature regression equation	DegF/F	IWT-PARM2	Literature/Site/Calib.
BWTFM(12)	Monthly values for BWTF	degF/F	MON-BWTF	Literature/Site/Calib.
CSNOFG	Flag to specify if snow is considered; 1=yes, 0=no	N/A	IWT-PARM1	Option
ELEV	Elevation of ILS above sea level	ft	IWT-PARM2	Site
SOCO2	Initial CO2 content of surface runoff	mg	IWT-INIT	Site

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

IMPLND Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
SODOX	Initial DO content of surface runoff	mg/l	IWT-INIT	Site
SOTMP	Initial temperature of surface runoff	Deg F	IWT-INIT	Site
WTFVFG	Flag to specify if water temperature regression parameters AWTF and BWTF vary monthly; 1=yes, 0=no	N/A	IWT-PARM1	Option
SNOW	Same as Snow list for PERLND Module			

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
ADCALC				
CRRAT	Ratio of maximum velocity to mean velocity in RCHRES cross-section under typical flow conditions	N/A	ADCALC-DATA	Literature/Site
VOL	Volume of water in the RCHRES at the start of the simulation (not necessary if section HYDR is active)	ac.ft.	ADCALC-DATA	Site
GQUAL				
ADPM(1-6,1)	Partition coefficients for generalized quality constituent among: 1-suspended sand, 2-suspended silt, 3-suspended clay, 4-bed sand, 5-bed silt, 6-bed clay	l/mg	GQ-KD	Literature/Calib.
ADPM(1-6,2)	Transfer rate between adsorbed and desorbed states for generalized quality constituent. First subscript same as above.	/day	GQ-ADRATE	Literature/Calib.
ADPM(1-6,3)	Temperature correction coefficients for adsorption/ desorption for generalized quality constituent. First subscript same as above.	N/A	GQ-ADTHETA	Literature
ALPH(18)	Base absorption coefficients for 18 wavelengths of light (see HSPF Manual, p. 175) passing through clear water	/cm	GQ-ALPHA	Literature
BIO	Concentration of biomass causing biodegradation of generalized quality constituent.	mg/l	GQ-BIOPM	Literature/Calib.
BIOCON	Second order rate constant for biomass concentration causing biodegradation of generalized quality constituent.	/mg.day	GQ-BIOPM	Literature/Calib.
BIOM(12)	Monthly values of biomass concentration causing biodegradation of generalized quality constituent.	mg/l	MON-BIO	Literature/Calib.
C(3,3)	Matrix of relationship between parent and daughter compounds for a decay process.	N/A	GQ-DAUGHTER	Literature/Site/Calib.
CFGAS	Ratio of volatilization rate for generalized quality constituent to oxygen reaeration rate	N/A	GQ-CFGAS	Literature
CLD	Constant or initial value of cloud cover	tenths	GQ-VALUES	Site

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
CLDFG	Source of cloud cover data: 1 - time series; 2 - constant; 3 - monthly	N/A	GQ-GENDATA	Option
CLDM(12)	Monthly values of cloud cover	tenths	MON-CLOUD	Site
CONCID	Identifier for concentration units of generalized quality constituent.	N/A	GQ-QALDATA	Option
CONV	Conversion factor from QTYID/VOL (where VOL is ft3 or m3) to concentration units specified by CONCID	N/A	GQ-QALDATA	Option
DEL(18)	Increments to base absorption coefficient for 18 wavelengths of light (see HSPF Manual, p. 175) passing through plankton-laden water	l/mg.cm	GQ-DELTA	Literaturer
DQAL	Initial concentration of generalized quality constituent.	concid	GQ-QALDATA	Site
FSTDEC	First order decay rate for generalized quality constituent.	/day	GQ-GENDECAY	Literature/Site/Calib.
GAMM(18)	Increments to base absorbance coefficient for 18 wavelengths of light (see HSPF Manual, p. 175) passing through sediment-laden water	l/mg.cm	GQ-GAMMA	Literature
GQID(5)	Identifier for generalized quality constituent	N/A	GQ-QALDATA	
GQPM2(7)	GQPM2(1-6) are flags indicating whether the generalized quality constituent is a "daughter" product through each of the decay processes. 0 - no; 1 - yes. 1) HDRL - hydrolysis 2) OXID - oxidation by free radical oxygen 3) PHOT - photolysis 4) VOLT - volatilization 5) BIOD - biodegradation 6) GEN - general first order decay GQPM2(7) indicates source of biomass data: 1 - time series; 2 - constant; 3 - monthly	N/A	GQ-FLG2	Literature/Site
KA	Second order acid rate constant for hydrolysis	/M-sec	GQ-HYDPM	Literature
KB	Second order base rate constant for hydrolysis	/M-sec	GQ-HYDPM	Literature
KBED	Decay rate for generalized quality constituent adsorbed to bed sediment	/day	GQ-SEDDECAY	Literature

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
KCLD(18)	Light extinction efficiency of cloud cover for 18 wavelengths of light (see HSPF Manual, p. 175)	N/A	GQ-CLDFACT	Literature
KN	First order rate constant of neutral reaction with water	/sec	GQ-HYDPM	Literature
KOX	Second order rate constant for oxidation by free radical oxygen	/M-sec	GQ-ROXPM	Literature
KSUSP	Decay rate for generalized quality constituent adsorbed to suspended sediment	/day	GQ-SEDDECAY	Literature/Site
LAT	Latitude of the RCHRES. Positive for North, negative for South.	degrees	GQ-GENDATA	Site
NGQUAL	Number of generalized quality constituents	N/A	GQ-GENDATA	Option
PHFLAG	Source of pH data (1=time series, 2=constant, 3=monthly values)	N/A	GQ-GENDATA	Option
PHOTPM(1-18)	Molar absorption coefficients for the generalized quality constituent for 18 wavelengths of light. (See HSPF Manual, p. 175.)	/M.cm	GQ-PHOTPM	Literature
PHOTPM(19)	PHOTPM(19) is the quantum yield in air-saturated pure water.	M/E	GQ-PHOTPM	Literature
PHOTPM(20)	PHOTPM(20) is the temperature correction coefficient for photolysis.	N/A	GQ-PHOTPM	Literature
PHVAL	Constant or initial value of pH	pH	GQ-VALUES	Site
PHVALM(12)	Monthly pH	pH	MON-PHVAL	Site
PHY	Constant or initial value of phytoplankton concentration	mg/l	GQ-VALUES	Literature/Site
PHYM(12)	Monthly phytoplankton concentration	mg/l	MON-PHYTO	Literature/Site
PHYTFG	Source of phytoplankton data: 1 - time series; 2 - constant; 3 - monthly	N/A	GQ-GENDATA	Option

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
QALFG(7)	Flags indicating which processes affect a generalized quality constituent. 0 - no; 1 - yes. 1) HDRL - hydrolysis; 2) OXID - oxidation by free radical oxygen; 3) PHOT - photolysis 4) VOLT - volatilization 5) BIOD - biodegradation 6) GEN - first order general decay 7) SDAS - sediment adsorption/desorption	N/A	GQ-QALFG	Literature
QTYID	Identifier for mass units of generalized quality constituent	N/A	GQ-GQALDATA	
ROC	Constant or initial free radical oxygen concentration	mole/l	GQ-VALUES	Site
ROCM(12)	Monthly free radical oxygen concentration	mole/l	MON-ROXYGEN	Site
ROXFG	Source of free radical oxygen concentration data: 1 - time series; 2 - constant; 3 - monthly	N/A	GQ-GENDATA	Option
SDCNC	Constant or initial total suspended sediment concentration	mg/l	GQ-VALUES	Site
SDCNCM(12)	Monthly values of total suspended sediment concentration	mg/l	MON-SEDCONC	Site
SDFG	Source of sediment concentration data: 1 - time series; 2 - constant; 3 - monthly	N/A	GQ-GENDATA	Option
SQAL(6)	Initial concentrations of generalized quality constituent on: 1-suspended sand, 2-suspended silt, 3-suspended clay, 4-bed sand, 5-bed silt, 6-bed clay	concu/mg	GQ-SEDCONC	Site
TEMPFG	Source of water temperature data: 1 - time series; 2 - constant; 3 - monthly	N/A	GQ-GENDATA	Option
TEMPM(12)	Monthly water temperature	degF	MON-WATEMP	Site
THBED	Temperature correction coefficient for decay of generalized quality constituent on bed sediment	N/A	GQ-SEDDECAY	Literature
THBIO	Temperature correction coefficient for biodegradation	N/A	GQ-BIOPM	Literature
THFST	Temperature correction coefficient for first order decay	N/A	GQ-GENDECAY	Literature
THHYD	Temperature correction coefficient for hydrolysis	N/A	GQ-HYDPM	Literature

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
THOX	Temperature correction coefficient for oxidation by free radical oxygen	N/A	GQ-ROXPM	Literature
THSUSP	Temperature correction coefficient for decay of generalized quality constituent on suspended sediment	N/A	GQ-SEDDECAY	Literature
TWAT	Constant or initial water temperature	degF	GQ-VALUES	Site
HTRCH				
AIRTMP	Initial air temperature at the RCHRES	degF	HEAT-INIT	Site
CFSAEX	Correction factor for solar radiation (it includes fraction of RCHRES surface exposed to radiation)	N/A	HEAT-PARM	Literature/Site
ELDAT	Difference in elevation between RCHRES and air temperature gage (positive if RCHRES is higher than the gage)	ft	HEAT-PARM	Site
ELEV	Mean RCHRES elevation	ft	HEAT-PARM	Site
KATRAD	Longwave radiation coefficient	N/A	HEAT-PARM	Literature
KCOND	Conduction-convection heat transport coefficient	N/A	HEAT-PARM	Literature
KEVAP	Evaporation coefficient	N/A	HEAT-PARM	Literature
TW	Initial water temperature in the RCHRES	degF	HEAT-INIT	Site
HYDR				
AUX1FG	Flag to specify if subroutine AUXIL will be called to compute depth, stage, surface area, average depth, and topwidth, and these parameters will be printed out; 1=yes, 0=no	N/A	HYDR-PARM1	Option
AUX2FG	Flag to specify if average velocity and average cross-sectional area will be calculated and printed out; 1=yes, 0=no	N/A	HYDR-PARM1	Option
AUX3FG	Flag to specify if shear velocity and bed shear stress will be calculated; 1=yes, 0=no	N/A	HYDR-PARM1	Option
COLIND(5)	Pair of columns used to evaluate the initial value of F(VOL) component of outflow demand for the exit	N/A	HYDR-INIT	Option/Site
CONVFM(12)	Monthly F(VOL) adjustment factors	N/A	MON-CONVF	Option

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES (Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
DB50	Median diameter of bed sediment (assumed constant throughout the run)	in	HYDR-PARM2	Literature/Site
DELTH	Drop in water elevation from upstream to downstream extremities of the RCHRES	ft	HYDR-PARM2	Site
FTABNO	If FTBDSN = 0, user's number for F-Table in FTABLES Block, if FTBDSN > 0, WDM table indicator specifying which table within WDM dataset given by FTBDSN contains the F-Table	N/A	HYDR-PARM2	Option
FTBDSN	If greater than zero, WDM table dataset number containing the F-Table; if 0, indicates F-Table is UCI FTABLES Block	N/A	HYDR-PARM2	Option
FUNCT(5)	Determines function used to combine components of an outflow demand -- 1 = MIN(F(VOL),G(T)); 2 = MAX(F(VOL),G(T)); 3 = SUM(F(VOL,G(T))	N/A	HYDR-PARM1	Site
KS	Weighting factor for hydraulic routing	N/A	HYDR-PARM2	Literature/Site
LEN	Length of the RCHRES	miles	HYDR-PARM2	Site
ODFVFG(5)	Determines F(VOL) component of outflow demand -- 0 means outflow demand does not have a volume dependent component; if greater than 0, indicates column number in RCHTAB which contains F(VOL) component; if less than 0, the absolute value indicates the element of array COLIND( ) which defines a pair of columns in RCHTAB which are used to evaluate the F(VOL) component	N/A	HYDR-PARM1	Option/Site
ODGTFG(5)	Determines G(T) component of outflow demand -- 0 means outflow demand does not have such a component; greater than 0 indicates element number of array OUTDGT( ) which contains G(T) component	N/A	HYDR-PARM1	Option/Site
OUTDGT(5)	G(T) component of the initial outflow demand for each exit from the RCHRES	ft3/s	HYDR-INIT	Option/Site
STCOR	Correction to RCHRES depth to calculate stage -- Depth + STCOR = Stage	ft	HYDR-PARM2	Site

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
VCONFG	Flag to specify if F(VOL) outflow demand components are multiplied by a factor which is allowed to vary monthly; 1=yes, 0=no	N/A	HYDR-PARM1	Option/Site
VOL	Initial volume of water in the RCHRES	ac.ft.	HYDR-INIT	Site
NUTRX				
ADNHFG	Flag to specify if NH4 adsorption is simulated; 1=yes, 0=no	N/A	NUT-FLAGS	Option
ADNHPM(3)	Partition coefficients for NH4-N adsorbed to sand, silt,and clay	ml/g	NUT-ADSPARM	Literature/Site/Calib.
ADPOFG	Flag to specify if PO4 adsorption is simulated; 1=yes, 0=no	N/A	NUT-FLAGS	Option/Site
ADPOPM(3)	Partition coefficients for PO4-P adsorbed to sand, silt,and clay	ml/g	NUT-ADSPARM	Literature
AMVFG	Flag to specify if ammonia vaporization is enabled; 1=yes, 0=no	N/A	NUT-FLAGS	Option/Site
ANAER	Concentration of dissolved oxygen below which anaerobic conditions exist	mg/l	NUT-BENPARM	Literature/Site/Calib.
BNH4(3)	Constant bed concentrations of NH4-N adsorbed to sand, silt,and clay	mg/kg	NUT-BEDCONC	Literature/Site/Calib.
BPCNTC	Percentage, by weight, of biomass which is carbon	N/A	CONV-VAL1	Literature/Site
BPO4(3)	Constant bed concentrations of PO4-P adsorbed to sand, silt,and clay	mg/kg	NUT-BEDCONC	Literature/Site/Calib.
BRPO4(1)	Benthal aerobic release of ortho-phosphate	mg/m2.hr	NUT-BENPARM	Literature/Calib.
BRPO4(2)	Benthal anaerobic release of ortho-phosphate	mg/m2.hr	NUT-BENPARM	Literature/Calib.
BRTAM(1)	Benthal aerobic release of total ammonia	mg/m2.hr	NUT-BENPARM	Literature/Calib.
BRTAM(2)	Benthal anaerobic release of total ammonia	mg/m2.hr	NUT-BENPARM	Literature/Calib.
CVBO	Conversion from milligrams biomass to milligrams oxygen	mg/mg	CONV-VAL1	Literature
CVBPC	Conversion from biomass expressed as phosphorus to carbon equivalency	mols/mol	CONV-VAL1	Literature
CVBPN	Conversion from biomass expressed as phosphorus to nitrogen equivalency	mols/mol	CONV-VAL1	Literature
DENFG	Flag to specify if denitrification is enabled; 1=yes, 0=no	N/A	NUT-FLAGS	Literature/Site
DENOXT	Dissolved oxygen concentration threshhold for denitrification	mg/l	NUT-NITDENIT	Literature/Calib.

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES (Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
EXPNVG	Exponent in gas layer mass transfer coefficient equation for NH3 volatilization	N/A	NUT-NH3VOLAT	Literature
EXPNVL	Exponent in liquid layer mass transfer coefficient equation for NH3 volatilization	N/A	NUT-NH3VOLAT	Literature
KNO220	Nitrification rate of nitrite at 20 degrees C	/hr	NUT-NITDENIT	Literature/Site/Calib.
KNO320	Denitrification rate at 20 degrees C	/hr	NUT-NITDENIT	Literature/Site/Calib.
KTAM20	Nitrification rate of ammonia at 20 degrees C	/hr	NUT-NITDENIT	Literature/Site/Calib.
NO2	Initial concentration of nitrite (as N)	mg/l	NUT-DINIT	Site
NO2FG	Flag to specify if nitrite is simulated; 1=yes, 0=no	N/A	NUT-FLAGS	Literature/Site
NO3	Initial concentration of nitrate (as N)	mg/l	NUT-DINIT	Site
PHFLG	Source of pH data (1=time series, 2=constant, 3=monthly values)	N/A	NUT-FLAGS	Option
PHVAL	Constant or initial value of pH	pH	NUT-DINIT	Site
PO4	Initial concentration of ortho-phosphorus (as P)	mg/l	NUT-DINIT	Site
PO4FG	Flag to specify if ortho-phosphorus is simulated; 1=yes, 0=no	N/A	NUT-FLAGS	Option
SNH4(3)	Initial concentrations of NH4-N adsorbed to sand, silt, and clay	mg/kg	NUT-ADSINIT	Site
SPO4(3)	Initial concentrations of PO4-P adsorbed to sand, silt, and clay	mg/kg	NUT-ADSINIT	Site
TAM	Initial concentration of total ammonia (as N)	mg/l	NUT-DINIT	Site
TAMFG	Flag to specify if total ammonia is simulated; 1=yes, 0=no	N/A	NUT-FLAGS	Option
TCDEN	Temperature correction coefficient for denitrification	N/A	NUT-NITDENIT	Literature
TCNIT	Temperature correction coefficient for nitrification	N/A	NUT-NITDENIT	Literature
OXRX				
BENOD	Benthal oxygen demand at 20 degrees C (with unlimited DO concentration)	mg/m2.hr	OX-BENPARM	Literature/Site/Calib.
BOD	Biochemical oxygen demand	mg/l	OX-INIT	Site
BRBOD(1)	Benthal release of BOD at high oxygen concentration	mg/m2.hr	OX-BENPARM	Literature/Site/Calib.
BRBOD(2)	Increment to benthal release of BOD under anaerobic conditions	mg/m2.hr	OX-BENPARM	Literature/Site/Calib.

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
CFOREA	Correction factor in lake reaeration equation to account for good or poor circulation characteristics	N/A	OX-CFOREA	Literature/Site
DELTH	Energy drop over length of RCHRES	ft	OX-LEN-DELTH	Site
DOX	Dissolved oxygen	mg/l	OX-INIT	Site
ELEV	RCHRES elevation above sea-level	ft	ELEV	Site
EXPOD	Exponential factor in the dissolved oxygen term of the benthal oxygen demand equation	N/A	OX-BENPARM	Literature/Site
EXPRED	Exponent to depth used in calculation of reaeration coefficient	N/A	OX-REAPARM	Literature/Site
EXPREL	Exponential factor in the dissolved oxygen term of the benthal BOD release equation	N/A	OX-BENPARM	Literature/Site
EXPREV	Exponent to velocity used in calculation of reaeration coefficient	N/A	OX-REAPARM	Literature/Site
KBOD20	Unit BOD decay rate @ 20 degrees C	/hr	OX-GENPARM	Literature/Site/Calib.
KODSET	Rate of BOD settling	ft/hr	OX-GENPARM	Literature/Calib.
LEN	Length of the RCHRES	miles	OX-LEN-DELTH	Site
REAK	Empirical constant for equation used to calculate reaeration coefficient	/hr	OX-REAPARM	Literature/Site
REAKT	Empirical constant in Tsivoglou's equation for reaeration (escape coefficient)	/ft	OX-TSIVOGLOU	Literature/Site
REAMFG	Indicates method used to calculate reaeration coefficient for free-flowing streams: 1) Tsivoglou; 2) Owens, Churchill, or O'Connor-Dobbins method is used depending on velocity and depth of water; 3) coefficient is calculated as a power function of velocity and/or depth -- user inputs exponents for velocity and depth and an empirical constant (REAK)	N/A	OX-FLAGS	Option/Site
SATDO	Dissolved oxygen saturation concentration	mg/l	OX-INIT	Literature/Calib.
SUPSAT	Allowable dissolved oxygen supersaturation (expressed as a multiple of DO saturation concentration)	N/A	OX-GENPARM	Literature/Site/Calib.
TCBEN	Temperature correction coefficient for benthal oxygen demand	N/A	OX-BENPARM	Literature

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES (Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
TCBOD	Temperature correction coefficient for BOD decay	N/A	OX-GENPARM	Literature
TCGINV	Temperature correction coefficient for surface gas invasion	N/A	OX-TSIVOGLOU	Literature
TCGINV	Temperature correction coefficient for surface gas invasion	N/A	OX-REAPARM	Literature
TCGINV	Temperature correction coefficient for surface gas invasion	N/A	OX-TCGINV	Literature
PHCARB				
ALKCON	Number of the conservative constituent which is alkalinity	N/A	PH-PARM1	
BRCO2(1)	Benthal aerobic release of CO_2	mg/m2.hr	PH-PARM2	Literature/Site
BRCO2(2)	Benthal anaerobic release of CO_2	mg/m2.hr	PH-PARM2	Literature/Site
CFCINV	Ratio of carbon dioxide invasion rate to oxygen reaeration rate	N/A	PH-PARM2	Literature/Calib.
CO2	Initial value of CO_2 (as carbon) concentration	mg/l	PH-INIT	Site
PH	Initial value of pH	pH	PH-INIT	Site
PHCNT	Maximum number of iterations to pH solution	N/A	PH-PARM1	Option
TIC	Initial total inorganic carbon	mg/l	PH-INIT	Site
PLANK				
ALDH	High algal unit death rate	/hr	PLNK-PARM3	Literature/Site/Calib.
ALDL	Low algal unit death rate	/hr	PLNK-PARM3	Literature/Site/Calib.
ALNPR	Fraction of nitrogen requirements for phytoplankton growth satisfied by nitrate	N/A	PLNK-PARM1	Literature/Calib.
ALR20	Algal unit respiration rate at 20 degrees C	/hr	PLNK-PARM3	Literature/Site/Calib.
AMRFG	Flag to specify if ammonia retardation of nitrogen limited growth is enabled; 1=yes, 0=no	N/A	PLNK-FLAGS	Option/Site
BALFG	Flag to specify if benthic algae are simulated; 1=yes, 0=no	N/A	PLNK-FLAGS	Option/Site

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
BENAL	Benthic algae, as biomass	mg/m2	PLNK-INIT	Site
CFBALG	Ratio of benthic algal to phytoplankton growth rate	N/A	BENAL-PARM	Literature/Calib.
CFBALR	Ratio of benthic algal to phytoplankton respiration rate	N/A	BENAL-PARM	Literature/Calib.
CFSAEX	Factor used to adjust input solar radiation to make it applicable to the RCHRES; for example, to account for shading of the surface by trees or buildings	N/A	SURF-EXPOSED	Site
CLALDH	Chlorophyll "A" concentration above which high algal death rate occurs	ug/l	PHYTO-PARM	Literature/Calib.
CMMLT	Michaelis-Menten constant for light limited growth	ly/min	PLNK-PARM2	Literature
CMMN	Nitrate Michaelis-Menten constant for nitrogen limited growth	mg/l	PLNK-PARM2	Literature
CMMNP	Nitrate Michaelis-Menten constant for phosphorus limited growth	mg/l	PLNK-PARM2	Literature
CMMP	Phosphate Michaelis-Menten constant for phosphorus limited growth	mg/l	PLNK-PARM2	Literature
DECFG	Flag to specify if linkage between carbon dioxide and phytoplankton growth is decoupled; 1=yes, 0=no	N/A	PLNK-FLAGS	Option/Site
EXTB	Base extinction coefficient for light	/ft	PLNK-PARM1	Literature
LITSED	Multiplication factor to total sediment concentration to determine sediment contribution to light extinction	l/mg.ft	PLNK-PARM1	Literature/Site
MALGR	Maximal unit algal growth rate	/hr	PLNK-PARM1	Literature/Site/Calib.
MBAL	Maximum benthic algae density (as biomass)	mg/m2	BENAL-PARM	Literature/Site/Calib.
MXSTAY	Concentration of plankton not subject to advection at very low flow	mg/l	PHYTO-PARM	Literature/Calib.
MZOEAT	Maximum zooplankton unit ingestion rate	mg/hr	ZOO-PARM1	Literature/Site/Calib.
NALDH	Inorganic nitrogen concentration below which high algal death rate occurs (as nitrogen)	mg/l	PLNK-PARM3	Literature/Site
NONREF	Nonrefractory fraction of algae and zooplankton biomass	N/A	PLNK-PARM1	Literature/Calib.
NSFG	Flag to specify if ammonia is included as part of available nitrogen supply in nitrogen limited growth calculations; 1=yes, 0=no	N/A	PLNK-FLAGS	Option/Site
ORC	Dead refractory organic carbon	mg/l	PLNK-INIT	Site

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES (Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
OREF	Outflow at which concentration of plankton not subject to advection is midway between SEED and MXSTAY	ft3/s	PHYTO-PARM	Literature/Site
ORN	Dead refractory organic nitrogen	mg/l	PLNK-INIT	Site
ORP	Dead refractory organic phosphorus	mg/l	PLNK-INIT	Site
OXALD	Increment to phytoplankton unit death rate due to anaerobic conditions	/hr	PLNK-PARM3	Literature
OXZD	Increment to unit zooplankton death rate due to anaerobic conditions	/hr	ZOO-PARM1	Literature
PALDH	Inorganic phosphorus concentration below which high algal death rate occurs (as phosphorus)	mg/l	PLNK-PARM3	Literature/Calib.
PHYFG	Flag to specify if phytoplankton is simulated; 1=yes, 0=no	N/A	PLNK-FLAGS	Option/Site
PHYSET	Rate of phytoplankton settling	ft/hr	PHYTO-PARM	Literature/Site/Calib.
PHYTO	Phytoplankton, as biomass	mg/l	PLNK-INIT	Site
RATCLP	Ratio of chlorophyll "A" content of biomass to phosphorus content	N/A	PLNK-PARM1	Literature/Site
REFSET	Rate of settling for dead refractory organics	ft/hr	PHYTO-PARM	Literature/Site/Calib.
SDLTFG	Flag to specify if influence of sediment washload on light extinction is simulated; 1=yes, 0=no	N/A	PLNK-FLAGS	Option/Site
SEED	Minimum concentration of plankton not subject to advection (i.e. at high flow)	mg/l	PHYTO-PARM	Literature/Site/Calib.
TALGRH	Temperature above which algal growth ceases	degF	PLNK-PARM2	Literature
TALGRL	Temperature below which algal growth ceases	degF	PLNK-PARM2	Literature
TALGRM	Temperature below which algal growth is retarded	degF	PLNK-PARM2	Literature
TCZFIL	Temperature correction coefficient for filtering	N/A	ZOO-PARM2	Literature
TCZRES	Temperature correction coefficient for respiration	N/A	ZOO-PARM2	Literature
ZD	Natural zooplankton unit death rate	/hr	ZOO-PARM1	Literature/Calib.
ZEXDEL	Fraction of nonrefractory zooplankton excretion which is immediately decomposed when ingestion rate > MZOEAT	N/A	ZOO-PARM2	Literature/Site
ZFIL20	Zooplankton filtering rate at 20 degrees C	l/mg.hr	ZOO-PARM1	Literature/Site/Calib.
ZFOOD	The quality of zooplankton food	N/A	PLNK-FLAGS	Literature
ZOMASS	Average weight of a zooplankton organism	mg/org	ZOO-PARM2	Literature/Site

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
ZOO	Zooplankton	org/l	PLNK-INIT	Site
ZOOFG	Flag to specify if zooplankton are simulated; 1=yes, 0=no	N/A	PLNK-FLAGS	Option/Site
ZRES20	Zooplankton unit respiration rate at 20 degrees C	/hr	ZOO-PARM1	Literature/Site/Calib.
RCHRES				
ADFG	Flag to specify if section ADCALC active; 1=yes, 0=no	N/A	ACTIVITY	Option
CONSFG	Flag to specify if section CONS active; 1=yes, 0=no	N/A	ACTIVITY	Option
GQALFG	Flag to specify if section GQUAL active; 1=yes, 0=no	N/A	ACTIVITY	Option
HTFG	Flag to specify if section HTRCH active; 1=yes, 0=no	N/A	ACTIVITY	Option
HYDRFG	Flag to specify if section HYDR active; 1=yes, 0=no	N/A	ACTIVITY	Option
IUNITS	Units in input time series--1=English, 2=Metric	N/A	GEN-INFO	Option
LKFG	Indicates whether the RCHRES is a lake (1) or a stream/river (0)	N/A	GEN-INFO	Option/Site
NEXITS	Number of exits from the RCHRES	N/A	GEN-INFO	Option
NUTFG	Flag to specify if section NUTRX active; 1=yes, 0=no	N/A	ACTIVITY	Option
OUNITS	Units in output time series--1=English, 2=Metric	N/A	GEN-INFO	Option
OXFG	Flag to specify if section OXRX active; 1=yes, 0=no	N/A	ACTIVITY	Option
PFLAG(10)	Printout level	N/A	PRINT-INFO	Option
PHFG	Flag to specify if section PHCARB active; 1=yes, 0=no	N/A	ACTIVITY	Option/Site
PIVL	Number of intervals between level 2 printouts	N/A	PRINT-INFO	Option
PLKFG	Flag to specify if section PLANK active; 1=yes, 0=no	N/A	ACTIVITY	Option
PUNIT(2)	Fortran output unit for English and/or Metric units. 0=none for that system.	N/A	GEN-INFO	Option
PYREND	Calendar month of end of year	N/A	PRINT-INFO	Option
RCHID(5)	Identifier for a RCHRES	N/A	GEN-INFO	Option
SEDFG	Flag to specify if section SEDTRN active; 1=yes, 0=no	N/A	ACTIVITY	Option
UUNITS	Units in UCI--1=English, 2=Metric	N/A	GEN-INFO	Option
RQUAL				
BENRFG	Flag to specify if benthal influences to be considered; 1=yes, 0=no	N/A	BENTH-FLAG	Option/Site
SCRMUL	Multiplier to increase benthal releases during scouring	N/A	SCOUR-PARMS	Literature/Site/Calib.

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
SCRVEL	Velocity above which effects of scouring on benthal release rates is considered	ft/sec	SCOUR-PARMS	Literature/Site/Calib.
SEDTRN				
BEDDEP	Initial total depth (thickness) of the bed	ft	BED-INIT	Literature/Site
BEDWID	Width of cross-section over which HSPF will assume bed sediment is deposited regardless of stage, top-width, etc	ft	SED-GENPARM	Site
BEDWRN	Bed depth which, if exceeded (eg, through deposition) will cause a warning message to be printed	ft	SED-GENPARM	Literature/Site
D	Effective diameter of the transported sand particles (Not used. DB50 is used instead)	in	SAND-PM	Literature/Site
D	Effective diameter of silt or clay particles	in	SILT-CLAY-PM	Literature/Site
DB50	Median diameter of bed sediment (assumed constant throughout the run)	in	SED-HYDPARM	Site
DELTH	Drop in water elevation from upstream to downstream extremities of the RCHRES	ft	SED-HYDPARM	Site
EXPSND	Exponent in sandload power function formula	complex	SAND-PM	Literature/Site/Calib.
Fracclay	Initial fraction (by weight) of clay in the bed material	N/A	BED-INIT	Site
Fracsand	Initial fraction (by weight) of sand in the bed material	N/A	BED-INIT	Site
Fracsilt	Initial fraction (by weight) of silt in the bed material	N/A	BED-INIT	Site
KSAND	Coefficient in sandload power function formula	complex	SAND-PM	Literature/Site/Calib.
LEN	Length of the RCHRES	miles	SED-HYDPARM	Site
M	Erodibility coefficient of the sediment	lb/ft2.d	SILT-CLAY-PM	Literature/Calib.
POR	Porosity of the bed (volume voids/total volume)	N/A	SED-GENPARM	Site
RHO	Density of sand particles	gm/cm3	SAND-PM	Literature/Site
RHO	Density of silt or clay particles	gm/cm3	SILT-CLAY-PM	Literature/Site

HSPF Parameter List for PERLND, IMPLND, & RCHRES MODULES
(Continued)

RCHRES Parameter List

NAME	DEFINITION	UNITS	TABLE	DATA SOURCE
SANDFG	Indicates the method for sandload simulation: 1 = Toffaleti method; 2 = Colby method; 3 = user-specified power function method	N/A	SANDFG	Option
SSED(3)	Initial concentrations in suspension of sand, silt, and clay	mg/l	SSED-INIT	Site
TAUCD	Critical bed shear stress for deposition	lb/ft2	SILT-CLAY-PM	Literature/Calib.
TAUCS	Critical bed shear stress for scour	lb/ft2	SILT-CLAY-PM	Literature/Calib.
W	Fall velocity of transported sand particles in still water	in/sec	SAND-PM	Literature/Site
W	Fall velocity of silt or clay particles in still water	in/sec	SILT-CLAY-PM	Literature/Site